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SOFTWARE APPLICATIONS DEDICATED TO SPATIAL DATA PROCESSING

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Abstract: Nowadays GIS become one of the most used technologies for data processing. Practically it represents a collection of tools which transform geographically-referenced data into information that is fit for various purposes [1]. This means that it was just a small step for GIS applications to be used for spatial databases development related to the monitoring of the environmental risk factors in order to evaluate their impact and to improve the environmental management quality. In this respect, GIS became the main technology used for the applications designed in the frame of the three years research PN2 Project "Sustainable Management System of Resources Used for Monitoring and Evaluating the Environmental Risks in Order to Prevent the Negative Effects and to Manage Crises Situations - MEMDUR". This paper emphasizes the applications used for spatial data processing and present some results related to the spatial position of the air pollution punctual sources with impact on Târgovişte city environment and two graphical models for pollutants concentration dispersion.

INTRODUCTION

A *GIS* (Geographic Information System) integrates hardware, software and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. Practically, it represents computer software that links geographic information (where things are) with descriptive information (what things are). Unlike a flat paper map which "borrows" the concept of "what you see is what you get", a *GIS* can present many layers of different information [2].

GIS technology can be used in scientific investigations, resource management and development planning. Generally, *GIS* applications (at urban and rural level) have two specific aims: the administration and monitoring of the territory and the local development planning. Usually, for achieving those two aims, it is necessary to design a database which is exploited using different functions. By example, for the applications which target to urban administration and monitoring, the query functions (based on various attributes) are common, a great importance being given to the data updating process. On the other hand, for the applications which have the local development planning as objective, analysis and modeling functions are required.

GIS is the main technology used for the applications designed in the frame of the three years research PN2 Project "Sustainable Management System of Resources Used for Monitoring and Evaluating the Environmental Risks in Order to Prevent the Negative Effects and to Manage Crises Situations - MEMDUR", code D11-037/18.09.2007, webpage: http://memdur.ssai.valahia.ro. The main objective of this project is to design, develop, test and implement in Dâmbovița County an advanced management system which has to assure the evaluation of the environmental risk in order to administrate the crises situations, in accordance with the demands required by the sustainable development on local, regional and national level [3]. Considering the *GIS* technology, finally, the proposed system will offer methods and technologies for spatial databases development related to the monitoring of the environmental risk factors in order to evaluate their impact and to improve the environmental management quality.

MATERIALS AND METHODS

In the initial phase, the collecting of the *GIS* data involved the estimation and the spatial framing of the limitative factors or the dispersion of the noxes which affect the analyzed surface through the using of specific instrumentation for monitoring and establishing the locations for data recording using *GPS*. In the next step, the recorded data is used for the development of an integrated monitoring plan which involves the using of thematic digital maps with the help of specific *GIS* software. In this sense, in the established critical locations, *GPS* receivers were used for recording their specific data with a 4 m precision with the help of a *dGPS* module.

Environmental atmospheric parameters are monitored (wind speed and direction, air temperature and humidity, atmospheric pressure, solar radiation, precipitation quantity) as well as noxes (CO, NO, NO_2, SO_2, PM10 dusts). Measured data is recorded into the database as time function samples and dispersion analysis can be realized using specific software programs. The software methodology involves the using of the spatial database for increasing the efficiency of the management system.

Finally, the management system will have two minimal components:

a. *Spatial databases*: contain the vectorial representation of the real world attached to a coordinates system and the alphanumerical representations which include technical attributes (values) of the objects and also the events appeared in critical industrial points. Three elements (typical to spatial database) will be implemented: *position* - usually in terms of spatial coordinates; *attributes* - characteristics of geographic entities (pollution factors names, admitted limit values, current values and alarming thresholds); *spatial relations* - relative position of the entities;

b. *Applicative software* for the creation, maintaining and exploiting of databases and also for data communication. The technology is client-server oriented using the procedures saved into the database management server.

GIS technology is required for designing the graphical entities and data processing: geo-referencing, vectorization and mapping. Digitization is used for designing the digital plan and populating the spatial database.

Having in view the experience gained in *GIS* area, three options (software platforms) for designing the applications were chosen: *GeoMedia*, *MicroTOP* and *GeoTrans*.

GeoMedia

GeoMedia is the suite of software components in *Intergraph Corporation*'s *Geographic Information System*. It is developed as client software specifically for the *Microsoft Windows* environment. *GeoMedia* is currently in version 6.1 - a very stable, full featured *GIS* tool [4].

The core technology of *GeoMedia* makes it possible to read data directly from dozens of other vendor's *GIS* data sources such as *ESRI Shape files*, *ESRI Coverage*, *Autodesk*, *Bentley*, *Oracle Spatial*, *Map Info* etc. With *GeoMedia* these data sources can be read simultaneously and merged to create one seamless *GIS*.

GeoMedia offers a series of advantages:

a. *Stability* - a strong attribute for Intergraph solutions, which recommend *GeoMedia* to be used in strategic areas: military, communications etc.;

b. *Scalability* - the system can be updated with the view to increase the number of transactions and concurrent users through adding of a new server (in parallel), by example. *GeoMedia* can manage a spatial database that work with the most important *Database Management Systems*: *Oracle Spatial*, *Oracle Object Model*, *MS SQL Server*, *MS Access*;

c. *Interoperability* - this offers the possibility to work simultaneously with different graphical formats or GIS platforms (*shp, shx, dxf, dgn* etc);

d. *Open standards – GeoMedia* is a system based on the *OpenGIS* standards.

MicroTOP

MicroTOP application is dedicated to topo-geodesic data processing. It is developed specifically for *Microsoft Windows* and proposes a friendly user interface having also the *dynamic help* facility.

The application manages the data in *Microsoft Access* (*MicroTOP.mdb*) which can allow various queries, verifications and reports.

Here are some main functions and facilities of *MicroTOP* application: (a) makes a preliminary verification of the initial data; (b) process different forms and complex pathways; (c) corrects the distance function of temperature and pressure; (d) allows the orientation of the pathway using specific methods (retro-intersection, Hansen); (e) allows the network compensation through the indirect measurement method in the case of over measurements; (f) exports the results to different *CAD* platforms (*MicroStation*, *AutoCAD*, *SmartSketch*).

MicroTOP can interpret the following data files:

a. *files downloaded from the total stations or field cards* (**.rw5* for *HP-FC48*, **.tc2* for *GTS200*, **.tc7* for *GTS700*, **.sdr* for *Sokkia*);

b. *files introduced manually* (**.stt* for *total stations*, **.teo* for *teodolit*, **.dah* for *Dahlta*).

GeoTrans

GeoTrans (*Geographic Translator*) is an application program which allows converting geographic coordinates among a wide variety of coordinate systems, map projections, and datums. It runs in *Microsoft Windows* and *UNIX Motif* environments.

For converting a set of coordinates, the procedure require simple operations: (a) select the coordinate system or map projection and the datum in which the coordinates are defined; (b) enter the source coordinates; (c) select the coordinate system or map projection and the datum to which is wanted the coordinates to be converted; (d) access the *Convert* button. The resulting coordinates will be displayed. Currently, twenty-five different coordinate systems, map projections, grids, and coding schemes, and over two hundred different datums, are supported.

GeoTrans can also be used to efficiently convert large numbers of coordinates contained in text files. The file format is very simple. A multi-line file header defines the coordinate system or map projection and datum of the coordinates contained in the file.

Following the header, each line contains a single set of coordinates, separated by commas [5]. Like any other geo-application, it proposes a friendly user interface.

RESULTS AND DISCUSSIONS

The geo-applications presented above were used for designing specific tasks inside the MEMDUR project. A series of results are presented below.

In figure 1, the white arrows illustrate the spatial position of the air pollution punctual sources (CO, NO, NO_2, SO_2 and PM10 dusts) with great impact on Târgovişte city environment. They are situated in the industrial area of the city. The whole graphical representation was obtained through the superposition of the vectorial data over the *orthophotoplan*.

An *orthophotoplan* can provide the experienced specialist with more information than the map of that particular locality itself. The map views information provided only for specification, the rest information being not preserved. Raster view allows to analyze additional, sometimes seeming absolutely insignificant, elements [6]. The analysis of the *orthophotoplan* showed that raster view gives the additional information on the territories and objects situated in them. This information could be used more widely not only by plotting territories in plans and maps but by carrying out territory evaluation works and charging the values of the objects as well [7].

Spatial positions of the air pollution punctual sources were also designed for other three towns from Dâmbovița County: Fieni, Doiceşti and Titu.

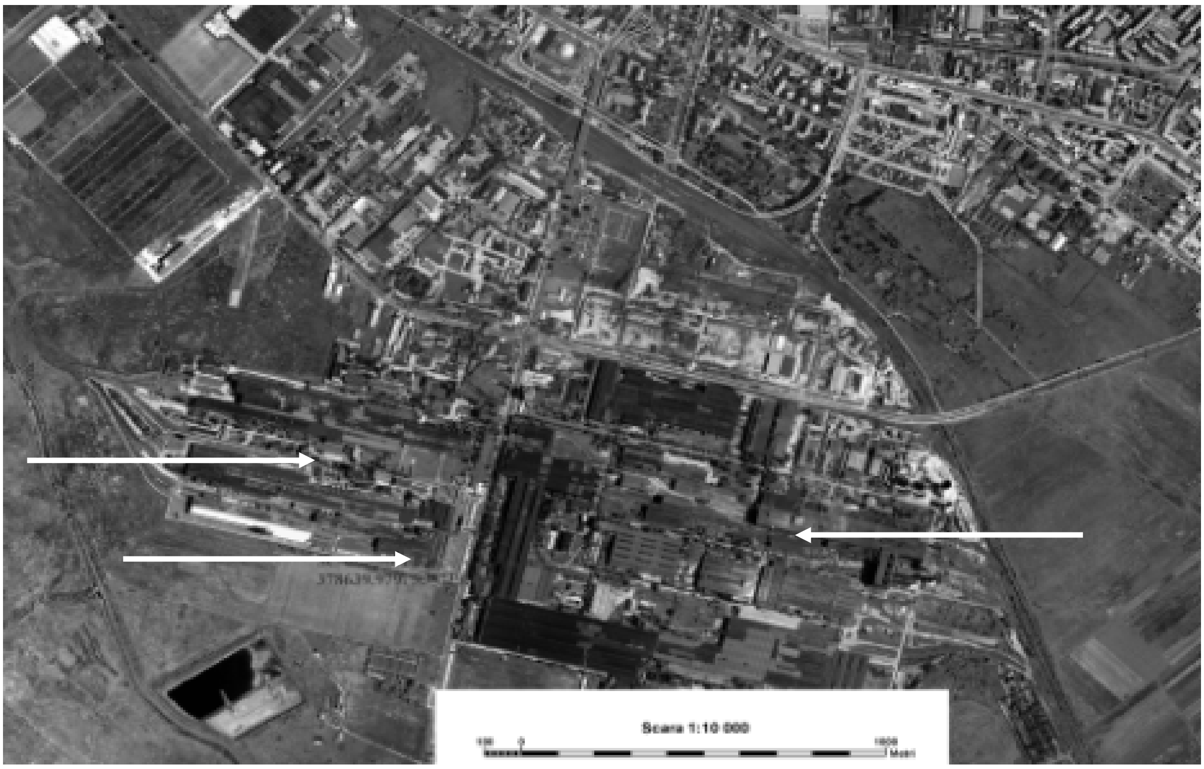

Figure 1

Spatial position of the air pollution punctual sources in Târgovişte city

Models for pollutants concentration dispersion were obtained and superposed over the digital plan of the same cities. The situation of Târgovişte city is illustrated for CO annual medium concentration (figure 2) and CO momentum maximum concentration (figure 3).

It is easy to remark that the major problems are presented in the industrial plant of the city (bottom of figures). Here, the CO annual medium concentration reaches the maximum of 34 μg/mc, within the distance between 800 and 1000 meters. Inside the city, the CO annual medium concentration reaches the maximum of 2 μg/mc. On the other hand, the CO momentum maximum concentration targets to 420 μg/mc, within the distance between 400 and 1000 meters. Inside the city, the CO momentum maximum concentration is situated between 80-160 μg/mc. Graphical representations were obtained also for NO, NO_2, SO_2 and PM10 dusts.

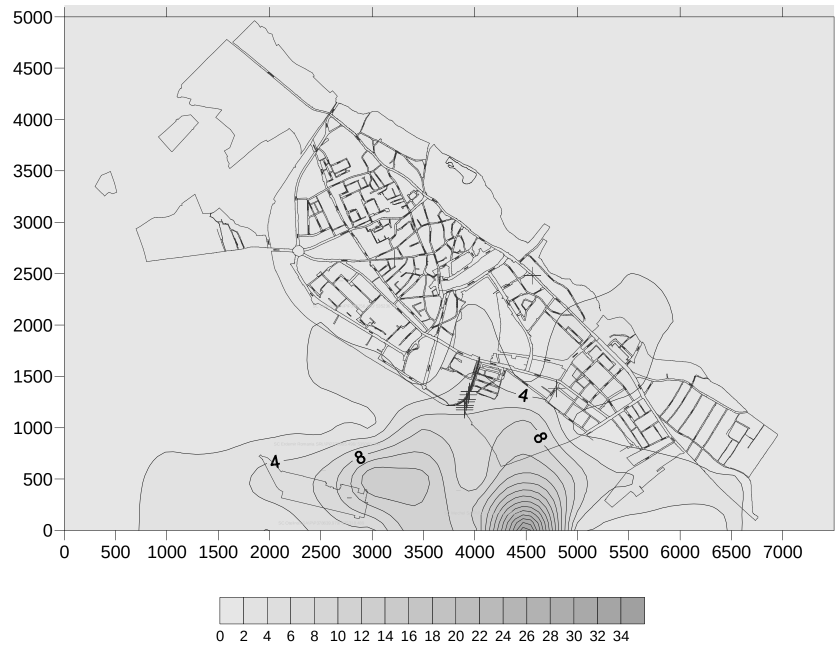

Figure 2

CO dispersion (annual medium concentration) in Târgovişte city

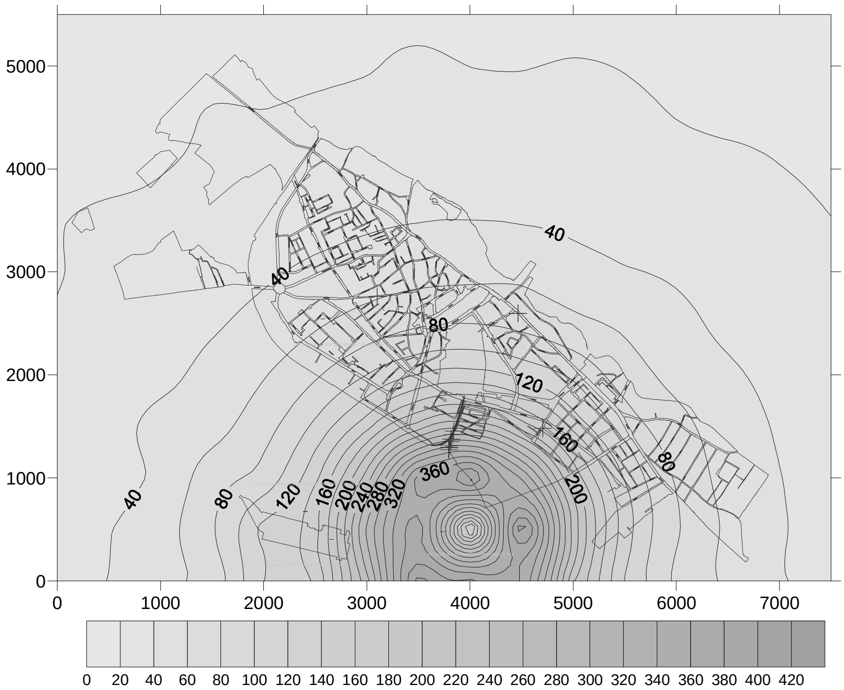

Figure 3

CO dispersion (momentum maximum concentration) in Târgovişte city

CONCLUSIONS

The proper selection of the environmental factors and air pollution sources allows a good estimation of risk situations. In this sense, choosing the best monitoring points and making the air pollutants analysis (noxes, powders) using both classical and modern methods will conduct to an efficient way for environment data processing through the on-line monitoring. A resource management system which can assure the evaluation of the environmental risk in order to administrate the crises situations, in accordance with the demands required by the sustainable development on local, regional and national level, can be designed through the integration of the GIS technologies. The results are extremely good and encourage the specialists to use GIS applications on a large scale. More, than that, increasing the mobility of data within systems and institutions, agreeing on the formats and standards, the development of integrated information for decision factors will be facilitated by web-services.

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